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George H. Ashley, State Geologist.

MINERAL RESOURCES

of the

LOWER ALLEGHENY - BEAVER RIVER DISTRICT.

By George H. Ashley.

Foreword. This is a brief statement of the mineral resources of one of twelve districts into which Pennsylvania may be divided on a geologic basis. Each district has much in common in its rocks, rock structure and mineral resources, different from those in other districts. Each bulletin describes briefly the economic mineral resources and gives references to sources of information.

This district. This district includes Beaver, Lawrence, Butler, Clarion, and Armstrong counties, the northern part of Allegheny County, and the north corner of Westmoreland County, extending down to latitude 40° 30' N. It is characterized by being underlain principally by the Allegheny group of rocks which includes coals, clays, etc., and the groups immediately over-and underlying.

Kinds of mineral resources. So far as known the mineral resources of the district are coal, oil, gas oil shale, clays, shales, sands. gravel, sandstone, limestone, iron ore, pyrite, salt, bromine, and chlorine.

Geology. The bedded rocks of the region were all deposited in Carboniferous time, and are overlain by surface formations of recent time. The Carboniferous rocks consist of the Pittsburgh series, including at the top, the Monongahela group (with the Pittsburgh coal at its base). Only 50 to 100 feet of the rocks overlying the Pittsburgh coal occur in a few hilltops along the south edge of the district. Next is the Conemaugh group, or "Lower Barren Coal Measures" of the earlier geologists; about 600 feet thick, containing many shales and sandstones, thin limestones, thin coals and clays. Then, forming the surface rocks

under most of the northern part of the district, is the Allegheny group or "Lower Productive Coal Measures" of the earlier geologists; about 4[illegible] feet thick, containing the Upper and Lower Freeport coals, the Upper, Middle and Lower Kittanning coals, the Upper and Lower Clarion, and Brookville coals, all of which are locally workable. Associated with the coals are valuable clays, shales, sandstones, thin limestones, notably the Vanport (which occurs a little below the Lower Kittanning coal) and some other rocks of value. Next underneath is the Pottsville subseries containing valuable sandstones, some clay and shale, and coal of local value. In northern Clarion County there outcrops along Allegheny River the 200 feet of the top of the Pocono subseries which belongs at the base of the underlying Mississippian (or Lower Carboniferous). The Upper Mississippian (Mauch Chunk) was removed during an uplift in time that exposed and permitted the removal of the rocks of Early Pottsville age and older rocks. Devonian strata from which some of the oil and gas of the district comes, lie many hundred to several thousand feet below water level.

The rocks of the district lie nearly flat but with a slightly rolling dip or incline toward the south or southeast. In the eastern part of the district folding becomes fairly pronounced, the folds having a general northeast-southwest direction.

Coal. A few hilltops in the southern part of the district contain the Pittsburgh coal, now largely worked out. The bulk of the coal being mined in the district today comes from the Allegheny group. The coal beds in this group are, as a rule, thin, from 2 to 4 feet or less. There is, however, in northern Allegheny County a considerable area of Upper Freeport coal 6 feet or more thick. All of the coals of this district are described in some detail in Pennsylvania Geological Survey Bulletin M6, Part II, which has been widely distributed in the district, but is no longer available.

In a general way the coals and the intervals average about as follows:

Coals of Allegheny group.

Upper Freeport coal, 2 to 10 feet thick (2 to 4 feet outside thick Freeport district.)

Interval, 35 to 65 feet (contains Upper Freeport clay and limestone, Bolivar flint clay, and Butler sandstone).

Lower Freeport coal, 2 to 5 feet thick, commonly less than 3 feet and absent in parts of the field.

Interval about 60 feet (40 to 80 feet), Lower Freeport clay and limestone, Freeport sandstone.

Upper Kittanning coal, normally about 1 to 3½ feet, locally partly cannel up to 14 feet.

Interval 40 to 50 feet, contains Upper Kittanning clay.

Middle Kittanning coal, 1 to 3 feet, usually thin but of good quality.

Interval 40 to 70 feet.

Lower Kittanning coal, 1 to 5 feet, generally persistent.

*Early Pottsville

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Interval 60 to 90 feet, contains the valuable Lower Kittanning clay 4 to 20 feet thick, Vanport limestone 1 to 22 feet thick, and shales of value.

Clarion coal or coals, locally in two or more beds. Thickness 0 to 7 feet, usually 1 to 4 feet.

Interval 20 to 35 feet.

Brookville coal, 1 to 4½ feet.

The coal of this district is all high-volatile or gas coal (33 to 37 per cent volatile matter), ash commonly low to medium, though locally high, B. t. u. 13,000 to 13,800, average about 13,500 on 6 per cent ash.

Estimated recoverable reserves in millions of tons: Beaver County 651; Lawrence County 484; Butler County 2,257; Clarion County 1,262; Armstrong County 2,491; Allegheny, Thick Freeport 507, Thin Freeport 557.

Reference: In addition to Part II of Bulletin M6, Parts I, III, and IV of the same bulletin are now in press. Part I gives general information about coal; Part III coal resources or reserves; Part IV, coal analyses. Reference should also be made to the United States Geological Survey atlases for detailed maps and descriptions.

Oil and gas. This district is in the heart of the oil and gas fields of Pennsylvania. Both oil and gas occur in porous sandstones, mainly in formations underlying the Coal Measures. The sands (sandstones) range from a few feet to 100 feet in thickness. Most of them are less than 50 feet thick. The first of these oil sands in this district is the Big Injun (Burgoon sandstone, top of Pocono) which outcrops along Allegheny River in the northern part of the district, but is below drainage under most of the district. The top of this sandstone is about 500 feet below the Upper Freeport coal. Using the Upper Freeport coal as a key horizon, some of the other beds in the district are the following distances below the Upper Freeport: First sand (Berea ?) 1,050 feet; Second sand (Hundred Foot or Gantz and Fifty Foot sands) 1,200 feet; Thirty Foot sand, 1,350 feet; Third sand, 1,450 feet; Fourth sand, 1,525 feet; Fifth sand or McDonald, 1,600; Sixth sand or Bayard, 1,675; Elizabeth sand, 1,750; Speechley sand, 2,400; and Bradford sand, 2,950 feet. These intervals decrease toward the north and increase toward the east.

Most of the production in this district has come from the Second or Hundred Foot sand, which is from 40 to 100 feet thick, with lesser amounts from the First or Berea, the Third, Fourth, Speechley, and Bradford sands. In Lawrence, Beaver and Butler counties both oil and gas are obtained. In Clarion County there is some oil but more gas. In Armstrong County oil is confined to the northwestern corner, but gas comes from all parts of the county. Oil wells from this district have an average initial production of from 1 to 10 barrels per day, the average being nearer the lower than the upper figure. The oil production of the several counties in this district in barrels in 1924 was as follows:

Allegheny (one-half)	233,632
Armstrong	21,350
Beaver	91,973
Butler	735,900
Clarion	203,685
Lawrence	24,215

In the same year 428 new wells were drilled in the Venango-Clarion field, and 157 in the Butler-Armstrong field.

Reference: Pennsylvania Geological Survey bulletin on Oil a[illegible]s Fields of Pennsylvania, Vol. 1, Introduction by George H. Ashley a[illegible]. French Robinson, 1922. Reports I to I5 of Second Geological Survey. [illegible]ield work looking to a new and much larger report is in progress.

Oil shales. This district covers the bulk of the oil shales of Pennsylvania. In 1860 oil was being produced from oil shales at eight places in Pennsylvania, practically all in this district, as follows: [illegible]dair and Veeder, Pittsburgh; Aladdin Company, Kiskiminetas; Anderson Company, Darlington; Enon Valley Company, Enon Valley; Lucesco Company, Kiskiminetas; New York Coal Oil Co., New Galilee; North American Company Kiskiminetas; Palestine Company, Palestine. (See Pennsylvania Geological Survey Bulletin M2, Oil Resources in Coals and Carbonaceous Shales of Pennsylvania by Charles R. Fettke).

Deposits in this area are small, consisting mainly of coal-roof shales, locally rich in bituminous matter, and "cannel shales" or cannel coal. These deposits are of very limited extent. The yield from these shales and coals ranges from 50 gallons of oil per ton from cannel coal, to 15 gallons per ton from some of the bituminous shales.

Clays and shales. The mining of clay and the making of clay products is one of the major industries in the area, as shown in the following table: (omitting Allegheny and Westmoreland counties) (1921).

County	Raw clay sold	Pottery	Building brick	Paving brick	Terra cotta and fire clay products
Armstrong	$ 60,600	$ 463,300	$ 950,400	$	$ 651,900
Beaver	36,900	590,600	1,363,000	222,000	737,500
Butler	58,500	.....	.....	.....	309,900
Clarion	58,200	3,600	.....	.....	374,500
Lawrence	4,300	757,800	57,200	634,200	413,600

The clays worked are those underlying the coal beds and the associated shales. Of these the clay under the Lower Kittanning coal is the best. It is from 2 to 20 feet thick. The other clays of value are: the Brookville clay, 2 to 15 feet thick; the Clarion clay, 3 to 12 feet thick; the Middle Kittanning clay, 2 to 5 feet thick, with a maximum of 15 feet; the Lower Freeport clay 3 to 5 feet thick; and the Upper Freeport clay 3 to 5 feet thick. They are of local value and are mined locally.

River clays found in the river bottoms and terraces are mined in places.

Shales are common both above and below the Upper Freeport coal. Many of these are suitable for making shale-brick and tile.

Flint clay is found in Clarion County and along Redbank Creek, where it is being mined by fire-brick manufacturers. The clay resources

of this region are being studied by the State Survey this year (1928). Except for the flint clays the clay and shale resources of the district are relatively unlimited.

Reference: Shaw, J. B., Fire Clays of Pennsylvania, Pennsylvania Geological Survey, Bulletin M10.

Sands, gravel, and sandstone. These mineral products are the foundation of a considerable industry in this district, an industry that may expand considerably with the opening of navigation on the Allegheny. Sand and gravel occurs at three horizons in the main stream valleys; in the river beds, along the river flood plains, and in terraces at various levels above the stream, the highest about 300 fett above river level. These terraces are remnants of old abandoned river channels. Sand and gravel from the terraces is free of coal, oil, or slime, and is thought therefore to be better for certain purposes than gravel from the bed of the river. These high terrace gravels lie on an old river floor now about 200 feet above the river. They range up to a mile or more in width, and up to 100 feet in thickness. Gravels at intermediate levels represent stages in the downcutting of the rivers. As a rule these intermediate gravels are not so thick and do not cover so large an area as those higher up. The gravels in the bottom of rivers are quite thick as the present channels are being cut in old filling, the rock being many feet below the bed of the river.

The sands of this district are used for many purposes, aside from road foundations and in concrete, such as for filtering, for molding iron, as engine and furnace sand, etc.

The Coal Measures of this district include several sandstones that locally are massive and suitable for structural work. The Homewood sandstone on Beaver River is extensively used for bridges and other large structures. Much of the stone in this district is brown or likely to oxidize brown, usually irregularly, producing color effects that render it unsuitable for high grade building purposes.

Reference: Stone, R. W., Molding Sands of Pennsylvania, Pennsylvania Geological Survey, Bulletin M11.

Limestone, lime, and cement. Limestones are fairly abundant in the Coal Measures, but most of them are thin and many of them shaly. The most valuable of these is the Vanport, or "ferriferous limestone" of the old Survey, lying a few feet under the Lower Kittanning coal. It is both thicker, and as a rule, purer than the other limestones, and underlies a very considerable area in this district. It has a thickness of 2 to 20 feet or more, and ranges from 88 to 96 per cent $CaCO_3$. While a large amount of this stone is available by the usual stripping methods, the amount to be obtained by underground mining is almost limitless (a square mile of limestone contains about 2 million tons for each foot of thickness).

The other limestones of this district are relatively thin, 1 to 5 feet, and most of them are shaly or sandy. The best of the other limestones are the Upper and Lower Freeport, which in places contain from 80 to 95 per cent $CaCO_3$. Aside from the two Freeport limestones the other limestones run from 50 to 65 per cent $CaCO_3$, and often show from 20 to 25 per cent of silica. The limestones of the district are low in magnesia, containing generally less than 10 per cent, though the bed under the Upper Kittanning coal runs higher locally.

The Vanport limestone is used not alone for road making and other uses for concrete, but supplies large amounts of stone for flux in

the iron industry, for lime, and for cement. There are at present in the district four cement plants producing about 4,000,000 barrels of cement annually. Two of these plants are quarrying the Vanport limestone where it is 20 feet thick and two are mining it undergrou

Reference: Miller, B. L., Limestones of Pennsylvania, Pennsylvania Geological Survey, Bulletin M7, (Out of print).

Iron ore. Iron ore was formerly mined in this district. The principal ore was a thin, irregular bed occurring directly on top of the Vanport limestone (Buhrstone ore). The ore was evidently a concentrate occurring only close to the surface where surface waters taking up iron from the overlying rocks came in contact with the limestone and replaced part of the limestone with iron. The outcrop of the Vanport Limestone is traceable around the hills by the remains of trenches where iron ore was formerly mined. Not all of the iron was taken out but its mining could not compete today with the cheaply mined ore from Michigan and Minnesota. There are some other smaller deposits but the only ores of present value are bog ores found in swampy lands and dug for use in purifying manufactured gas.

Pyrite (FeS_2). Pyrite is one of the important impurities in most coal beds. It occurs in the coal either finely divided and much scattered, as balls or plates, or occasionally as thin layers or partings between the coal benches, or as paper thin plates, along the joint faces. It must be separated from the coal and is usually brought to the surface because it tends to oxidize and produce spontaneous combustion. In some mines as much as one ton of pyrite for each 100 tons of coal is brought to the surface. Pyrite is at present used only in manufacturing sulphuric acid, and that only in times of sulphur shortage.

Reference: Pennsylvania Geological Survey mimeographed Bulletin No. 48, Pyrite from Bituminous Coal Mines in Pennsylvania, by Henry Leighton.

Salt and bromine. Salt was produced in Pennsylvania for many years by drilling wells into certain sandstones containing brine. This has been especially true in northeastern Allegheny County and adjoining regions, as at Tarentum, Freeport, Saltsburg, and along Kiskiminetas River. Thick beds of rock salt underlie this district, but at great depth, as they occur in the Upper Silurian. In addition to common salt, bromine and iodine have been found in these brines, and bromine was formerly extracted in this State. Salt is not produced in Pennsylvania at the present time.

Conclusion.

The above brief summary may have overlooked some mineral resources not at present being utilized, but it covers all that are recognized today as having possible commercial value. Unfortunately all of the Survey's reports then available for distribution were wiped out by fire in May 1927. The Pennsylvania Geological Survey invites inquiries for further information by letter or in person. Address State Geologist or Pennsylvania Topographic and Geologic Survey, Harrisburg, Pa.